# Space Weather Technical Forecast

Issued on Tuesday, 08 August 2023 at 01:28 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: G1-G2 Minor/Moderate storm likely from CME arrival day 1 (08 Aug). Recent X-flare (R3 Blackout) from over NW limb, bringing a likelihood of reaching S1 day 1. Further R1-R2 Blackouts likely day 1.**

## Analysis of Space Weather Activity over past 24 hours

**Solar Activity:** High due to the X1.5 flare from AR3386 from over the northwest limb, peaking at 07/2046 UTC. Three other M-flares were also observed, an M2.4 (peaking 07/0429 UTC) from the same region, and an M1.4 (07/1937 UTC) and M1.0 (broad flare from 07/1608-1632 UTC) from AR3387 in the northwest. Despite a relatively small size, this is the most active of the ten visible regions on the disc, likely due to its east-west parity separation and ongoing development, although it is now difficult to accurately assess due to its location close to the northwest limb. AR3394 is the largest region on the disc, now approaching the south-centre disc, but has remained stable despite the development of some small spots around the main dominant umbral core.

No Earth-directed CMEs were observed in the last 24 hours, with the fast CME from the X1.5 passing ahead of Earth.

**Solar Wind / Geomagnetic Activity:** A couple of weak and tentative CME arrivals perhaps occurred during this period, at 07/0010 and 07/1105 UTC. Solar wind speed, observed by ACE at L1, initially persisted around 400km/s, but rose gradually to around 500km/s after 07/1200 UTC. The density of the field remained below average. The main signal for the CMEs was the interplanetary magnetic field strength (Bt). This suddenly increased from weak field (5nT) at 07/0000 UTC to be moderate (10nT) at 07/0200 UTC, then smoothly eased back to weak levels (7nT) by 07/1100 UTC. This then rose suddenly again, to peak briefly moderate (14nT) before easing back to background (6-7nT) from 07/1600 nT. The north-south direction also rotated gradually through the period giving periods of negative (southward) and positive (northward) field, ranging from -9nT to 8nT. Phi angle was initially positive (away from the Sun), but became neutral from 07/1500 UTC, and then negative from 07/2200 UTC (towards the Sun). Geomagnetic activity was mostly Quiet to Unsettled (Kp0-3), but with one Active interval 07/2100-0000 UTC.

**Energetic Particles / Solar Radiation:** GOES-16 high energy (greater than 10 MeV) proton flux is below the S1 threshold having seen a declining trend for much of the period, after the M1.6 and X1.6 flares on 05 Aug. However, since 07/2100 UTC an increasing trend has been observed in response to the X1.5 flare peaking at 07/2046 UTC from the same region but from over the northwest limb. Peak value was 4.7pfu at 06/0245 UTC. GOES16 high energy (greater than 2MeV) electron flux was at background levels throughout. The associated 24-hour integrated fluence remained well below the Active level (1e8 integrated pfu), with 1.1e6 integrated pfu recorded at 08/0000UTC.

## Four-Day Space Weather Forecast Summary

**Solar Activity:** Further M-flares are likely day 1 (08 Aug), mainly from either of AR3386 over the northwest limb or AR3387 also in the northwest. The potential for further observable flares from AR3386 soon recedes however, with AR3387 also soon disappearing over the northwest limb on

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day 2 (09 Aug). Activity likely declining to Low but with a chance of rising to Moderate each day, day 3 (10 Aug) onward.

**Solar Wind / Geomagnetic Activity:** There are one or two further CME arrivals possible on day 1 (08 Aug). These are the CMEs from the M1.6 flare and the X1.6 flare of AR3386 on 05 Aug, although the former has potentially already arrived as a weak enhancement on 07 Aug. The latter is low confidence, due to the northwestern location of the source region, with the subsequent CME likely giving a glancing impact. Any enhancement day 1, perhaps persisting into day 2 (08-09 Aug) is likely to then ease with solar winds declining towards background day 3-4 (10-11 Aug). Any CME arrival or arrivals day 1 (08 Aug) are expected to give Active to G1/Minor Storm intervals, and a chance of G2 Moderate Storms. Otherwise, activity is expected to ease to be mainly Quiet with Unsettled intervals, mainly later day 2 (09 Aug) onward.

**Energetic Particles / Solar Radiation:** The high energy (greater than 10 MeV) proton flux is currently below the S1 Minor Storm Level, but with an increasing trend due to the X1.5 flare from AR3386 over the limb, peaking 07/2046 UTC. This is likely to rise above the S1 Minor Radiation Storm day 1 (08 Aug) before likely declining below this level again later on day 1. There remains a slight chance of further enhancements from this region, but declining by day 3 (10 Aug) as it recedes further around the far-side. The high energy (greater than 2 MeV) electron flux is expected to remain at background at first, but with a chance of rising to Moderate or High day 2 (09 Aug) onward once any CME influence recedes. The associated fluence is expected to remain below Active, but with a slight chance of rising above later in the period.

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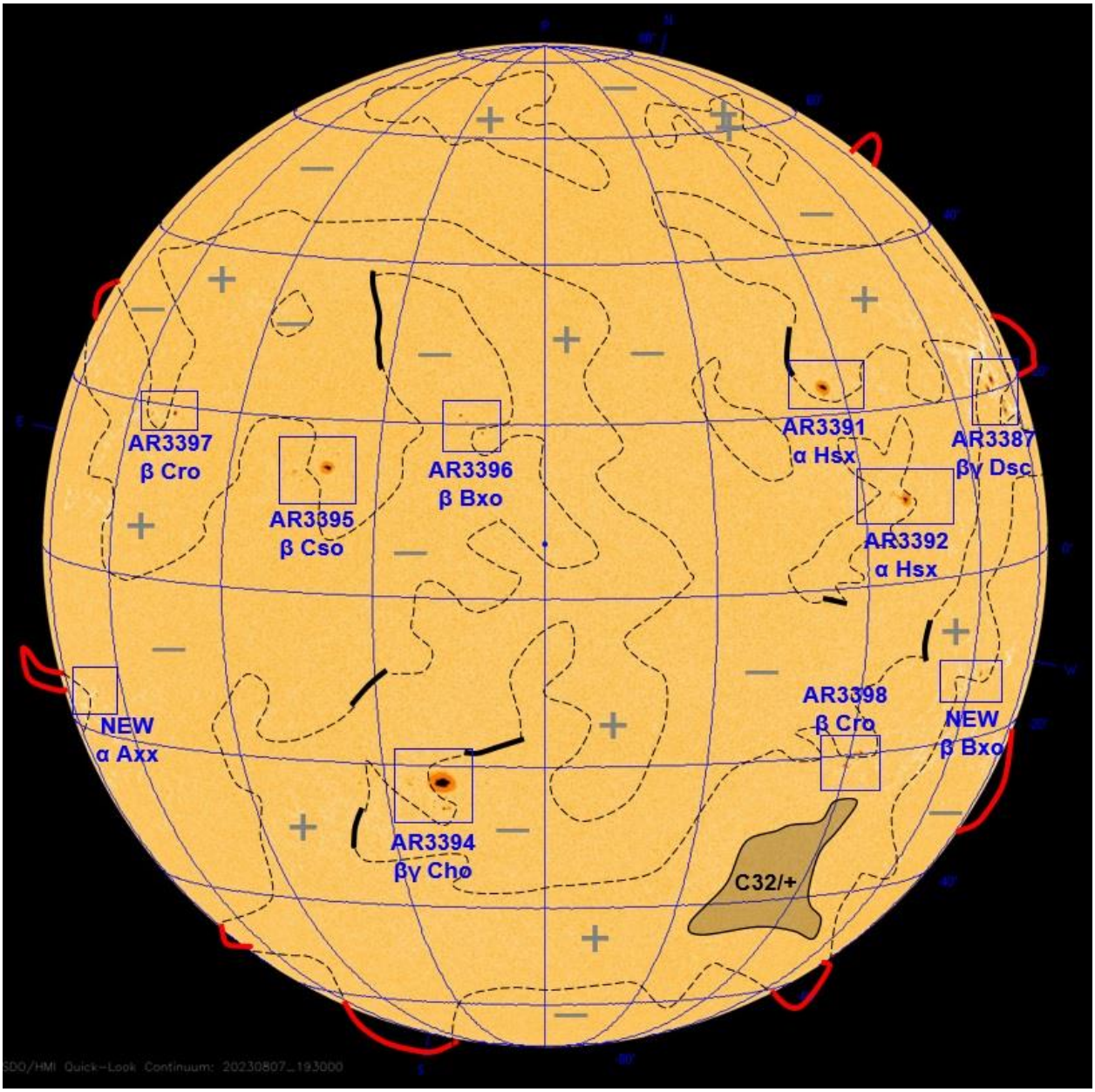
**Figure 1. Solar Analysis Valid 08/2000 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

Weak arrivals observed on 07 Aug are likely associated with CMEs from 04 Aug (AR3386 M2.0 flare), and potentially the first of the CMEs from 05 Aug (AR3386 M1.6 flare), although this attribution is low confidence with a chance of a further arrival due to this CME. This also leaves at least one further CME potentially glancing Earth on day 1 (08 Aug), from the X1.6 flare of AR3386. Analysis of this complex eruption is relatively low confidence, with a more Earth-directed component than would typically be expected given its location, any a much of the material passing ahead of Earth. A glancing arrival is most likely during the first half of day 1, with ongoing influence into day 2 (09 Aug).

If any arrival occurs, elevated solar winds are likely with geomagnetic activity increasing from Quiet to Unsettled, to be Active to G1/Minor Storm with a chance of G2 Moderate Storms. There is a slight chance of G3 Strong Storms. This activity would then ease day 2 (09 Aug) with winds easing to background speeds and activity persisting at Quiet with isolated Unsettled intervals thereafter.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 70 | 20 | 1 | 1 |
| Strong | G3 | No | 10 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 05/1030 | Partial | M1.6 AR3386 | NW | 1020 | 07/1800 UTC | Maybe weak arrival on 07 Aug, but chance of glancing blow on 08 Aug |
| 06/0505 | Partial | X1.6 AR3386 | NW | 1002 | 08/0230 -4/+12 hrs | Low confidence. Glancing blow most likely. |

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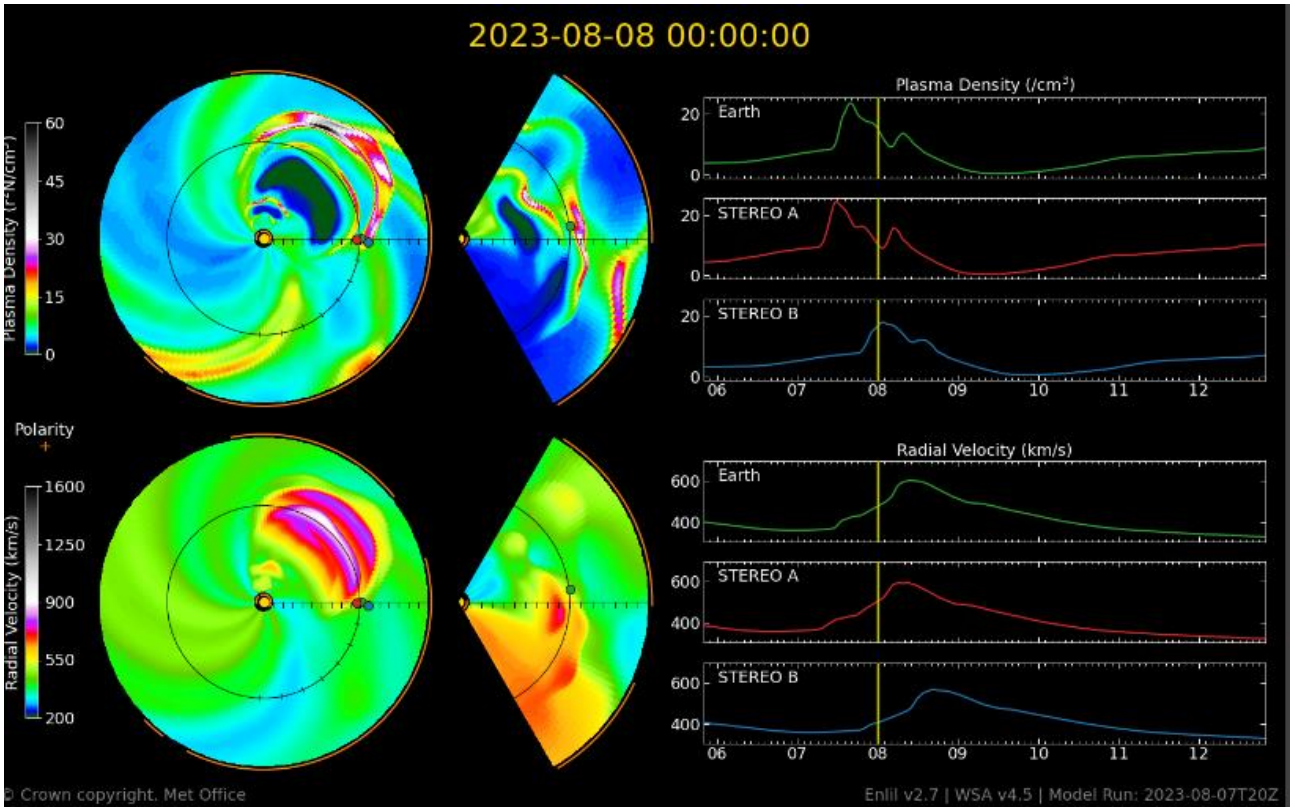
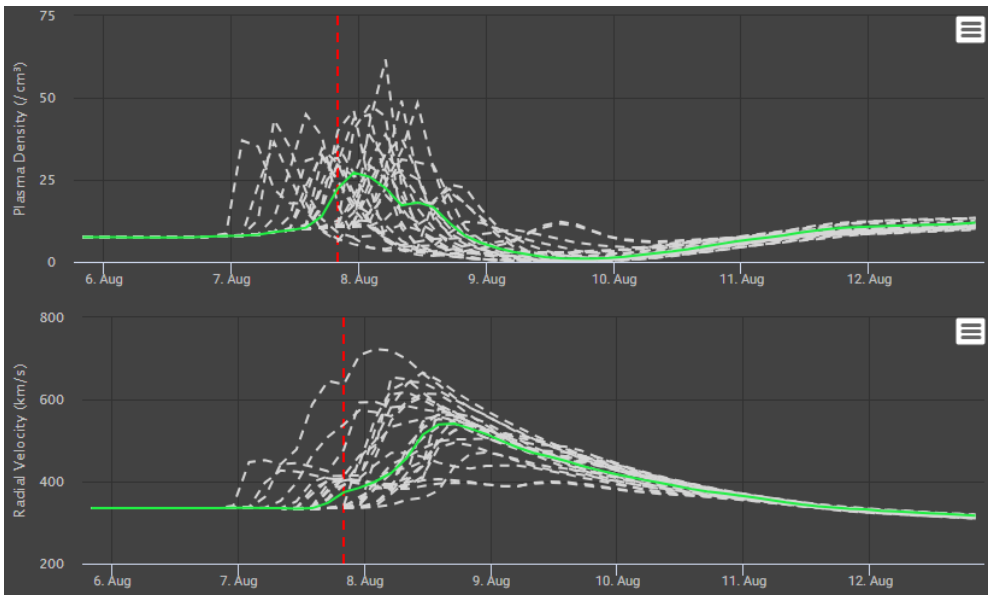
**Figure 2: Enlil and ensemble showing potential CME arrivals. Ensemble highlighting uncertainty, but with a gradual and weak enhancement due to glancing interactions on control run (green).**

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## Radio Blackouts - X-Ray Flares:

Solar Activity is currently High due to the X1.5 flare of AR3386 from over the northwest limb. This region is now moving further onto the far-side however given the history of this region, further visible flares cannot be completely ruled out for at least early day 1 (08 Apr).

There are currently ten regions on the visible disc, however these are generally small and simple. The main regions of interest are AR3387, now also approaching the northwest limb, and AR3394 now approaching the south-centre disc. AR3387 is a small but unusually orientated region, with its east-west parity separation line suggestive of an increased flare risk. This region is also become hard to analyse due to its movement towards the east limb, but has been the source of at least two small M-flares in the past 24 hours. AR3394 has remained inactive, dominated by a large central negative spot, but with the development of small positive spots to its southern edge and other small mixed polarity spots on its periphery.

| X Ray Flares<br>Probability | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| Active | R1-R2 M Class | Yes | 60 | 55 | 40 | 40 |
| Very Active | R3 to R5 X Class | Yes | 10 | 1 | 1 | 1 |

**Figure 3: GOES 16/18 X-ray flux and X1.5 flare of AR3386 on limb (right)**

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## Solar Radiation Storms - (High Energy Protons):

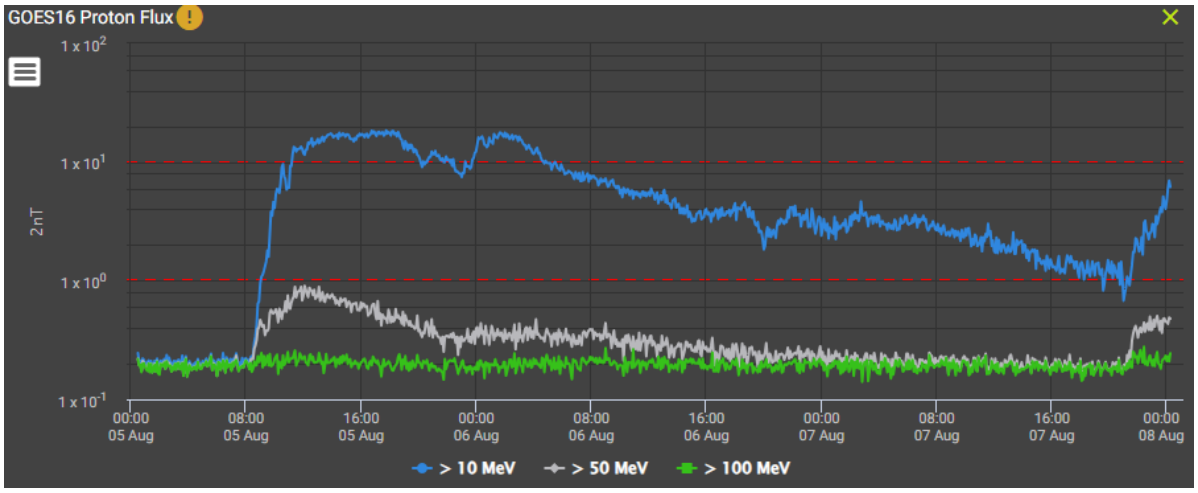
The high energy (greater than 10 MeV) proton flux observed by GOES16 has been below the S1 Minor Storm level (10pfu) and declining towards background, before a further enhancement occurred in response to the X1.5 flare from AR3386 peaking at 07/2046 UTC. A small increase has since been observed in both the 10MeV and 50MeV channels, and this has the potential to rise above the S1 early on day 1 (08 Aug) before easing again through the period, likely below during day 2 (09 Aug). Further flares from this region could enhance this further on day 1 and perhaps day 2, however the region should then be sufficiently far enough around the far-side to limit the risk of further notable proton enhancements.

There is only a very slight chance of further proton enhancements from elsewhere on the visible disc, given the general simplicity of the current sunspots on the disc.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 70 | 20 | 10 | 5 |
| **Very Active** | **≥ S3 *** | No | 2 | 1 | 1 | 1 |

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

**Figure 4: GOES-16 Proton Flux over the last 3 days. Current rising trend visible**

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### High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 10 MeV) observed by GOES16 is currently at background levels, with no enhancement at GEO currently observed from recent CME enhancements. Given the likely arrival of at last one further glancing CME day 1 (08 Aug), any increased flux is likely to be contained to lower orbits until solar wind pressure eases day 2 (09 Aug). Observed flux may then increase to become Moderate, perhaps High at times, although this is Low confidence.

Overall, the associated 24 hour fluence is likely to stay below the Active level, however there is a slight chance of this rising above, day 2 (09 Aug) onward. REFM is giving a good guide to background conditions, however this is likely to become unreliable as the solar wind enhancement from the recent CMEs wanes and the observed flux and fluence increases in response.

| GEO Electron Environment Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 5 | 20 | 30 | 30 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

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